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Economic Explanations of Fertility in the Presence of Immigration: The West German Case

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Abstract

The West German experience since 1950 with variable economic growth rates and rising then sharply falling birth rates provides useful data for estimating economic models of fertility. This paper improves previous estimates made for West Germany by considering explicitly the theoretical effects of large and varied changes in foreign immigration upon variants of the Becker model and the Easterlin model. It finds strong support for the model Easterlin applied to 19th century American experience (also characterized by large foreign immigration). However, even the "open" Easterlin model fails to explain fertility changes as well as a hybrid model that takes into account changes in women's labor force participation rates.

Economic Explanations of Fertility in the Presence of Immigration: The West German Case*

The economic and demographic experience of West Germany since 1950 provides us one of the richest and most varied storehouses of data available for a modern industrial country undergoing fertility decline. The decline in fertility in West Germany from the mid 1960s to the mid 1970s was the most dramatic among the advanced nations of the world. From 130.8 children per 1000 married women in 1963, the total fertility rate in the Federal Republic of Germany fell to 67.6 in 1975 and in 1979 it was still only 65. (Statistisches Jahrbuch, various issues.) Meanwhile, the rate of economic expansion for the West Germany society remained one of the highest in the Western world, with an average annual rate of growth of Gross National Product of 3.9% from 1964 to 1974. This rate, however, was falling steadily from the heights achieved during the economic miracle of the 1950s and early 1960s. Did the dramatic economic changes cause or influence strongly the very dramatic changes in fertility behavior as economists' theories would predict? (Becker, 1960; Easterlin, 1968.) Two recent studies (Wander, 1980; Ermisch, 1980) have found, indeed, strong support for the proposition that changes in economic variables caused the change in German fertility

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behavior over the past two decades. Wander favors the Easterlin hypothesis that changes in relative wages of the youngest cohort of the labor force generate the observed changes in fertility behavior. She modifies it, however, by including sociological trend variables, especially the changes from blue collar to white collar status among younger Germans. This follows lines suggested by Oppenheimer for the United States. (Oppenheimer, 1976; 1982.) Ermisch, on the other hand, favors the Becker hypothesis that changes in the earnings of working wives, the income of their husbands, and the income of husbands of non-working wives are the primary economic determinants of changes in fertility patterns. He also favors inclusion of an Easterlin-Oppenheimer variable, but chooses the ratio of actual to desired standard of living for younger workers in place of the status variable used by Wander.

This paper attempts to improve the results of the Ermisch and Wander studies by considering explicitly the effects of variables omitted from those studies, especially those reflecting the immigration experience of German society since 1950. The importance of refugees from the Eastern block countries in the 1950s and of temporary workers from Mediterranean countries of labor recruitment in the 1960s and early 1970s is as well-known as the economic miracle and the fertility decline. (Blitz, 1978; Kindleberger, 1974.) Neither Ermisch nor Wander makes explicit reference to this phenomenon despite the fact that it violates the assumptions of both the Becker thesis (implicitly) and the Easterlin thesis (explicitly). Introducing variables to take account of a large and growing immigrant population tilts the balance back towards the Easterlin hypothesis but

a different version than that employed by Ermisch and Wander. Rather than Easterlin's explanation of the American experience since WWII, which they apply to the German experience of the same time period, it is Easterlin's analysis of the American experience before World War I that is the more appropriate model for West Germany since 1950. But even this model needs to be modified to take into account the changed role of women in the labor force.

Section I explains the importance of immigration since 1950 for the two classes of fertility models when applied to Germany; Section II presents the regression results of structural modifications to take into account the openness of the German economic-demographic system; and Section III concludes with an analysis of the complexities of this system and an agenda for future research.

SECTION I. The Importance of Immigration for Economic Models of Fertility in West Germany since 1950.

Both the Becker and Easterlin models of fertility behavior take as their point of departure a closed demographic system, one in which changes in the total population arise only from natural increase, the excess of births over deaths. This is done for analytical convenience in the Becker case, since the basic decision-making unit is the nuclear family and not boarding houses or workers' dormitories. At this level of decision making, only decisions to adopt children or not could be construed as analogous to decisions to permit immigration or not. However, the economic effects of an adopted child are presumably the same as those of a natural child. Within the Becker framework, the effects of exogenous changes in immigration upon the nuclear family will presumably all be captured in the effects of immigration upon both male

and female wages. I will argue below that there may exist distinct influences of the presence of immigrants upon wives' decisions to join the labor force or not. Even if these may not be relevant for West Germany, the institutional constraints placed in West Germany upon wage structures may make quantitative measures of immigrants more sensitive indicators of wage pressures on younger households than the available wage data. But these arguments will become clearer after considering how the effects of immigration enter the Easterlin model.

Easterlin notes explicitly that his model applies to the United States only since World War II when the Full Employment Act of 1946 expressed the commitment of the Federal Government to maintain full employment while the national origins quotas of the immigration legislation from the early 1920s were kept in place, limiting more strictly than ever the influx of new immigrants, especially that made in response to economic conditions. (Easterlin, 1980.) In the absence of full employment policies, an excess supply of entry-level workers still drive up unemployment rates rather than holding down their wages relative to other workers. In the absence of bars to immigration, an excess demand for entry-level workers will increase immigration inflows rather than driving up wages of younger workers.

The effect of immigration upon fertility in the Easterlin model depends crucially upon assuming: 1) a low rate of substitution between younger and older men in the labor force; and 2) a high rate of substitution between younger and older women in the labor force. The first assumption implies that when a baby boom generation matures and enters the labor force the increased competition of young men for the available

entry level positions will decrease their earnings, both present and foreseen. This depresses the expected income situation of young adult households below the levels desired. The second assumption implies that young women in these households enter the labor force in greater proportions in order to restore household income to the levels desired. Both effects, reduced income relative to aspirations and increased female participation in the labor force, tend to reduce fertility. By contrast, when a baby bust generation matures and enters the labor force, the decreased supply of young men for entry level positions tends to increase their earnings, both present and foreseen. This reduces the need for young wives to enter the labor force. Both effects tend to increase fertility. The Oppenheimer model differs in that it argues that there are long term and irreversible trend effects present in the U.S. society tending to lower the incomes of young men relative to their aspirations, and that these are quantitatively more important than the medium term effects analyzed by Easterlin. (Oppenheimer, 1982.)

Since immigration streams are usually dominated by younger males in the labor force, the presence of large scale immigration will usually depress relative earnings and opportunities of younger men as well as tend to depress the general wage level. By inference, it should also tend to increase the labor force participation of young wives. Easterlin found direct evidence that the large waves of immigrants coming to the United States in the period 1865-1914 moderated medium term movements in the crude birth rates. (Easterlin, 1968; ch. 4.) The sharp reduction in immigration after World War I and the changes in the relative sizes of age cohorts became expressed increasingly as fluctuations in young men's

earnings and changes in young women's participation rates, with much stronger effects upon birth rates.

West Germany has had smaller commitments to full employment since World War II (and, overall, much more success in fulfilling these commitments) but, unlike the U.S., has had several large waves of immigration which have changed markedly the size and structure of the German labor force. The experience of West Germany can give us useful insights into the effects of large scale immigration upon fertility patterns in a modern developed country. The increase in foreign migration began in 1960, the same year that the smallest age cohort then in the German population, that born in the year 1945, began to enter the labor force. If the Easterlin hypothesis for the U.S. were to be applied to the West German situation of the 1960s, it would lead one to predict a rise in relative wages of younger workers that would persist through most of the decade. In fact, such a rise did not occur, at least in part because of the growth of foreign laborers occupying unskilled positions in construction and industry.

Table 1 below gives a summary of the development since 1950 of both the displaced persons and the foreigners in West Germany in relation to the total labor force and resident population. From the start of the Federal Republic, the presence of large numbers of displaced persons (vertriebene) and refugees created the economic effects and many of the social tensions that characterize open populations. By the end of the 1950s, when the vertriebene population had ceased to grow and most of the initial assimilation problems had been overcome, the foreign (non-German) population began to grow rapidly. Using the census results of

Table 1

The Development of Displaced Person and Foreign Labor Force and Population in West Germany, 1950-1980

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1950			47.562	49.843	0.548	1.1	8.024	16.1	3.324	15.3
1951			47.325	49.769	0.486	1.0	8.275	16.6		
1952			47.127	50.086	0.447	0.9	8.418	16.8		
1953			47.281	50.666	0.471	0.9	8.610	17.0		
1954	72906	0.4	48.484	51.146	0.463	0.9	8.732	17.1		
1955	79607	0.4	50.44	51.711	0.467	0.9	8.914	17.2		
1956	98818	0.5	52.395	52.326			9.069	17.3		
1957	108190	0.6	51.632	52.990			9.331	17.6	3.552	14.9
1958	127083	0.6	53.867	53.585			9.579	17.9	3.657	15.0
1959	166829	0.8	56.084	54.724			9.733	18.0	3.711	14.9
1960	279390	1.3	58.506	54.724			9.873	18.0	3.881	15.4
1961	507419	2.5	57.314	56.175	0.686		8.956	15.9	3.871	15.2
1962	655463	3.2	60.126	56.747			9.308	16.4	4.144	15.8
1963	811213	3.9	61.538	57.040			9.421	16.5	4.161	15.7
1964	932932	4.4	62.158	57.686			9.219	16.0		
1965	1164364	5.5	60.833	58.425			9.302	15.9	4.077	15.3
1966	1314031	6.2	59.508	59.065			9.296	15.7		
1967	1023747	4.8	57.505		1.807		9.254	15.6	3.863	14.9
1968	1014774	4.9	56.506	60.345	1.924	3.2	9.108	15.3	3.783	14.6
1969	1372059	6.6	56.502	61.069	2.381	3.9	9.089	15.1	3.814	14.5
1970	1838859	8.6	53.227	60.907	2.977	4.9	8.964	14.7	3.759	14.2
1971	2168766	10.0	52.842	61.502	3.439	5.6	8.659	14.3	3.635	13.8
1972	2316980	10.6	53.374	61.775	3.527	5.7				
1973	2595000	11.9	54.212	62.089	3.966	6.4				
1974	2331173	11.2	53.3	62.048	4.127	6.7				
1975	2070735	10.3	53.327	61.746	4.090	6.6				
1976	1937134	9.7	53.368	61.490	3.948	6.4				
1977	1888585	9.5	53.433	61.389	3.948	6.4				
1978	1869294	9.3	53.21	61.332	3.981	6.5				
1979	1933651	9.4	53.536	61.337	4.144	6.8				
1980	2071658	9.9	53.863		4.453					

Column Definitions:

1) Total number of foreigners employed in West Germany, 1954-1981;
2) Percentage of total labor force that is foreign;
3) Percentage that men aged 20-30 are of men aged 40-65;
4) Total resident population (millions) as of September 30;
5) Total foreign population (millions) as of September 30;
6) Percent foreign population of total population;
7) Total number of vertriebene resident in West Germany;
8) Percent vertriebene of total resident population;
9) Number of vertriebene in labor force;
10) Percent of labor force that are vertriebene;

Table 1 (continued)

SOURCES:

1 & 2: BUNDESANSTALT FÜR ARBEIT, Amtliche Nachrichten, Jahreszahlen, Nürnberg, 1982.

3: STATISTISCHES BUNDESAMT, Statistisches Jahrbuch, various issues, except:
1955: Average of 1954 and 1956;
1965: Average of 1964 and 1966;
1979: Average of 1978 and 1980;
1961: BUNDESINSTITUT FUR BEVÖLKERUNGSFORSCHUNG, Materialen zur Bevölkerungswissenschaft, Heft 18 "Langfristige Entwicklu[illegible] der Bevölkerung, ... in der BRD" Wiesbaden, 1980.
1970: Ibid.

NOTE: all age structures are for the end of the year except 1961 which is June 6 and 1970, which is May 27.

4-6: SOPEMI, 1980, p. 44; SOPEMI, 1981, p. 44; SOPEMI, 1982, p. 41.

7 & 8: STATISTISCHES BUNDESAMT, Fachserie A. BEVÖLKERUNG UND KULTUR, Reihe 4, Vertriebene und Flüchtlinger, "Bevölkerungs-, Kultur- und Wirtschaftstatistische Ergebnisse, 1954 bis 1966." for years 1950-1966. Statistisches Jahrbuch, various issues, for years 1967-1971.

9 & 10: Statistisches Jahrbuch, various issues.

May 27, 1970, we can calculate the relative openness of the German labor force on that date. The total resident labor force (Erwerbstätige) numbered 26,887,000 (Bib, 1980, p. 148) of which 24,607,000 were German (ibid., p. 150). But of these German members of the labor force, 4,751,000 were vertriebene and another 1,650,914 were Germans who had left East Germany. (Volkszählung vom 27. Mai 1970, Heft 22, "Vertriebene und Deutsche aus der DDR," p. 24.) In sum, 8.463 million members of the 1970 labor force in West Germany--31.5%--had migrated into West Germany from elsewhere.

The vertriebene population was spread evenly through most age groups and its weight in the labor force was somewhat less than its weight in the total population. (Compare cols. 8 and 10.) The foreign population, by contrast, was overwhelmingly concentrated among young males in the labor force. This created some interesting effects on the movement of cohort ratios in the German male population. Of special interest is column 3 in Table 1 which shows the ratio of men aged 20-30 to men aged 40 to 65 in each year since 1950. From a very low ratio of 47.6% in 1950 it declined further to 47.1% in 1952; rose to a peak of 62.2% in 1964; fell then quickly to a low of 52.8% in 1971; and has remained in the range of 52 to 54% throughout the remainder of the 1970s. The turning points in this ratio correspond very closely to the turning points in the fertility ratios in West Germany, warranting closer inspection of the Easterlin hypothesis for West Germany since World War II.

Table 2 shows what the age structure of West Germany's resident male population was in various benchmark years and compares this with the age structure of the resident German male population. This kind of exercise

Table 2

Age Structure of West Germany's Resident Male Population
With and Without Foreigners, 1950 to 1979

(Percentage of Total Male Population)

Age Group	1950	1961	1970	1975	1979
20-30 with foreign	14.6	16.8	14.3	13.3	14.3
" without foreign	14.6	16.5	13.5	12.8	14.2
30-40 with foreign	11.7	10.6	16.1	16.3	14.6
" without foreign	11.7	13.5	15.2	15.3	13.6
40-50 with foreign	15.8	10.6	12.4	13.4	14.9
" without foreign	15.8	10.5	12.3	13.3	14.8
50-60 with foreign	11.3	13.5	9.1	8.8	11.3
" without foreign	11.3	13.6	9.4	9.2	11.7
Ratio of 20-30/40-60					
with foreign	53.9	69.7	66.5	59.9	54.6
without foreign	53.9	68.5	62.2	56.9	53.6

SOURCE:

Bundesinstitut für Bevölkerungsforschung, Materialen zur Bevölkerungswissenschaft, Heft 18, "Langfristige Entwicklungen der Bevölkerung," p. 67.

does not measure the actual importance of foreign migrants for changing the ratio of different age cohorts since it takes no account of the likely changes that would have occurred without foreign migration in the age-specific patterns of German in- and out-migration. But since German in-migration was controlled by the policy measures of the Eastern bloc and since incentives to emigrate from Germany in the 1960s were nil, the results may reflect fairly closely what would have transpired. German migration figures for the period 1960-78 show a gradual decline in absolute amounts with a small net inflow of Germans from within Europe being offset by a small net outflow of Germans to countries outside Europe. (BiB, 1980, pp. 56-59.)

The bottom row of Table 2 shows the ratio of men aged 20-30 to men aged 40-60 in the benchmark years of 1950, 1961, 1970, 1975 and 1979. The ratios are calculated first on the basis of the total resident male population and then on the basis of just the resident German population. They show for the total male population basically the same sharp rise in the ratio of young to older men in the 1950s, the maintenance of this high ratio during the decade of the 1960s, and then a fall back to the level of 1959 by the year 1979. Our interest here is in the bottom row where the age cohort ratios for just the German (including vertriebene and East German refugees) male population are shown. These indicate that in the absence of foreign migration during the 1960s the ratio of younger to older men would have fallen significantly, dropping to 62.2% from the high point of 68.5% in 1961. During the 1970s, the character of foreign migration changed from temporary migration dominated by younger males to permanent migration dominated by family members. It is not surprising, then,

that in this period the cohort ratios with and without foreigners converged rapidly.

The picture that emerges from these calculations is that the swings in age cohort ratios during the 1950s and 1960s help explain the upswing in German fertility and then its decline. In the 1970s, however, the relative scarcity of young men returned close to the early 1950s level while the birth rate merely stopped its rapid decline and showed no signs of returning to pre-1960 levels. The presence of foreign migration in the 1960s helps explain the depth and the length of the decline in German fertility, while the change in the nature of migration during the 1970s helps explain the leveling off of fertility. This still leaves unanswered the question why fertility did not begin to rise rapidly in the last decade. Indeed, since births in the foreign population became a significantly larger portion of total births in West Germany during the 1970s (rising from 5.6% in 1969 to 13.0% in 1979), the continued presence of foreigners makes the puzzle of continued low fertility more interesting.

An obvious approach to solving this puzzle is to examine the course of women's participation rates in the labor force. Table 3 below summarizes the course of age-specific fertility rates for married women in Germany and their participation rates in the labor force in the benchmark years 1950, 1961, 1970, and 1980. During the period of rapid rise in the share of foreigners in the West German labor force, the decade of the 1960s, a marked slowdown occurred in the rise of participation rates by German married women. It rose sharply during the 1950s and rose sharply again during the 1970s. It may be mere coincidence that this pause in the upward trend of labor force participation rates of married

Table 3

Share in Labor Force by Age Group
All Women, Single Women, and Married, 1961-1980

Age	All Women			Single Women			Married Women		
	1961	1970	1977	1961	1970	1977	1961	1970	1977
15-20	78.2	64.4	45.3	79.5	64.9	--	55.0	58.2	59.0
20-25	71.9	67.1	70.5	90.4	84.4	--	49.0	54.2	64.5
25-30	50.7	51.5	58.8	91.4	88.9	--	39.0	44.0	52.2
30-35	44.6	44.9	52.3	89.9	89.2	--	36.2	39.1	47.2
35-40	46.3	46.1	51.3	88.8	88.2	--	37.9	40.8	47.0
40-45	45.4	48.1	52.2	86.3	87.8	--	37.8	42.0	47.9
45-50	42.3	48.4	50.1	82.3	86.4	--	35.6	41.4	44.6
50-55	38.1	43.0	47.4	77.3	81.6	--	31.7	36.5	40.5

SOURCES:

1961 & 1970: Wirtschaft und Statistik, October, 1973, p. 589.
1977: Wirtschaft und Statistik, August, 1978, p. 473.

women, especially in the prime childbearing years, occurred while foreign immigration suddenly emerged as an important source of German labor supply. The timing of the foreign immigration may help explain some of the anomalies in the course of change in birth rates and women's participation rates. The sharp fall in birth rates began in the mid-1960s when the labor force participation of women was rising only very slowly. But the rise in birth rates in the 1950s as well as the leveling off in the decline of birth rates in the 1970s occurred when participation rates were rising. (See Table 4.)

But this is not the only interesting fact contained in Table 3. The Easterlin thesis prediction that favorable cohort ratios for young men should lead to lower participation rates for young women while unfavorable ratios should raise their participation rates is also flatly contradicted by the West German experience. Participation rates of married women aged 15-25 rose sharply in the 1950s and the 1970s when the cohort ratios of men aged 20-30 were relatively favorable. By contrast, during the 1960s when the cohort ratios were quite unfavorable, the participation rates of younger married women stayed at much the same level. The increased presence of foreign male workers in the German labor force in this period seems to have discouraged rather than encouraged further participation by German married women. There is no explanation for this in the Easterlin framework.

At first sight, there appears to be no explanation for this phenomenon within the Becker framework either. The essential forces in the Becker framework are wage movements, male and female, with the male wages influencing birth rates positively and the female wages influencing them negatively (but only for those households with working wives).

Table 4

Age-Specific Birth Rates, Labor Force Participation Rates of Married Women in Germany, 1950, 1960, 1970, and 1980

Age	1950		1961	1960	1970		1980	
	BR	lfpr	BR	lfpr	BR	lfpr	BR	lrpf
15-20	74.6	30.3	92.9	54.8	109.8	56.3	54.2	55.3
20-25	126.3	28.5	171.6	49.0	125.3	52.5	105.0	62.3
25-30	111.8	27.0	128.1	38.9	94.1	42.5	80.9	55.3
30-40	32.9	26.0	26.5	37.0	19.7	38.5	7.3	51.0
40-50	--	26.8	--	36.6	--	41.1	--	49.3
50-60	--	25.4	--	29.3	--	32.0	--	36.7
60-65	--	19.8	--	18.4	--	15.0	--	11.2
65 +	--	12.7	--	9.8	--	6.4	--	3.2

SOURCE:

Labor Force Participation Rates: 1950, 1960 and 1970, Wirtschaft und Statistik, 1974, Heft 4, p. 266; 1980, Statistisches Jahrbuch, 1981, p. 92.

Birth Rates: 1950, 1961, 1970, Statistisches Jahrbuch, 1979, p. 71; 1980, Statistisches Jahrbuch, 1981, p.

If immigrants have economic effects in the labor markets, they should act through the changes in wages available for the native population. Strictly speaking, the effects of changes in female wages operate only on those women already in the labor force (Butz and Ward, pp. 319-21). In fact, however, increased immigration of foreign workers into specific women's occupations may lower entry wages below the reservation wages of German women. In this way immigration affects the participation rate of native women in the labor force over time and thereby decreases the importance of changes in female wages for fertility behavior. This may help explain, then, why women's participation rates in the labor force did not rise during the 1960s. It may also help explain why movements in women's wages do not aid our explanation of movements in the fertility rate in the regression analyses we now present.

Section II. Regression Analysis of the West German Economic-Demographic System.

Both Ermisch and Wander have provided the data series used in their regression analysis. These permit an attempt to replicate their statistical results and then to probe more deeply some of the problems of estimation that arise. Table 5 shows the results reported by Ermisch and Wander for the Easterlin and Becker theses respectively as well as my results achieved by estimating independently the same regressions reported with the data provided in their articles. Precise duplication was only possible in the Becker equation reported by Ermisch, but the other results are sufficiently close to lead one to suspect that a minor misprint may have occurred in one of the data series.

Table 5. Comparison of Regression Results, Time-Series Analysis of German Fertility Behavior.
(t-statistics are in parentheses)

A. Becker Thesis

A1. Wander Version

$$\ln K = a + b(1-q)G_{mj_{t-1}} + c(qG_{mj})_{t-1} + d(qG_{fi})_{t-1} + e(A_{mj})_{t-1}$$

	a	b	c	d	e	R^2	DW
orig.	2.981	-0.001	0.007	-0.014	0.100	0.925	0.705
	(9.585)	(-1.964)	(1.922)	(-2.950)	(5.208)		
dupl.	3.130	-0.002	0.004	-0.010	0.121	0.933†	0.851
	(12.54)	(-3.51)	(1.81)	(-3.16)	(7.20)		

A2. Ermisch Version

$$\Delta \ln F_t = a + b\,\Delta \ln Y_{t-1} + c\,Q_{t-1}\,\Delta \ln Y_{t-1} + d\,Q\Delta \ln WF_{t-1}$$

	a	b	c	d	R^2	DW
orig. (1957-77)	--	7.1484	-17.4290	0.5643	0.496	1.920
		(4.12)	(3.78)	(0.40)		
dupl. (1957-1977)	--	7.148	-17.427	0.564	0.379†	1.920
		(4.12)	(3.78)	(0.40)		
orig. (1952-77)		5.8282	-15.2231	1.1772	0.458	1.82
		(4.42)	(4.01)	(0.92)		
dupl. (1952-1977)		5.828	-15.22	1.177	0.395†	1.82
		(4.42)	(-4.35)	(0.92)		

B. Easterlin Thesis

B1. Wander Version

$$\ln K = a + b(G_m)_{t-2} + c(G_m/E_h')_{t-2} + d(G_m/E_h'') + e(A_m)_{t-2}$$

	a	b	c	d	e	R^2	DW
orig. (1959-1977)	12.142	-0.001	-1.430	-5.044	-0.058	.996	2.280
	(12.27)	(-4.372)	(-5.368)	(-6.427)	(-15.855)		
dupl. (1961-1977)	8.113	-0.0011	-2.164	-18.228	-0.031	.985†	1.359
	(9.846)	(-3.884)	(-4.19)	(-2.048)	(-3.795)		

(Table 5 continued)

B2. Ermisch Version

$$F_t = a + bRW_t + cW_{Ft} + dAGR_t + eF'_{t-1}$$

	a	b	c	d	e	R^2	DW
orig.	7.251	-1.241	-0.029	-0.246	0.374	0.932	0.931
	(2.55)	(-1.91)	(-2.36)	(-1.94)	(1.29)		
dupl.	7.21	-1.106	-0.030	-0.263	0.402	0.948†	
	(2.56)	(-1.936)	(-2.445)	(-2.088)	(1.418)		

†Adjusted for degrees of freedom.

Notes: Eqn. A1 is from Hilda Wander (1980), p. 21 where:
K = live births per 1,000 married women, ages 15-44
q = labor force participation rate of married women, ages 15-44
G_m = average gross wages and earnings (1970 prices) of male employees, all ages
G_f = average gross wages and earnings (1970 prices) of female employees, ages 15-44
A_m = share of male white collar and professional workers to all male employees, all ages

Eqn. A2 is from John F. Ermisch (1980), p. 132 where:
F = the total fertility rate (sum of age-specific fertility rates)
Y = men's real wage rate
WF = women's real wage rate
Q = standardized proportion of women aged 20-34 in the labor force

Eqn. B1 is from Wander (1980), p. 25 where:
K = live births per 1,000 women, ages 15-44
G_m' = average real wages and salaries of men workers ages 25-34
E_h'' = average income from gross wages and salaries of households whose head is 45-54 years old, ten years previously
E_h = average income from gross wages and salaries of households whose head is 35-44 years old
A = share of the male labor force ages 25-34 years who are white collar workers

Eqn. B2 is from John F. Ermisch (1980), p. 128 where:
F = the total fertility rate
RW = the relative wage (ratio of men's expected wages in year t to the desired standard of living in that year) (This is calculated as a seven year moving average of previous experienced real wages)
W_F = women's real wage rate
AGR = percentage of men working in agriculture
F' = estimated total fertility rate, lagged on year

The striking thing from the regression results using levels of the variables is the high level of correlation with R^2 all in the neighborhood of .9 and higher, coupled with serious problems of serial correlation, shown by values of the Durbin-Watson statistic in the range of .8 to 1.2. Ermisch's version of the Becker thesis eliminates the problem of serial correlation by taking the first differences of natural logarithms but then correspondingly reduces the coefficient of determination.

The econometric difficulties of autocorrelated residuals and multicollinearity among independent variables are well-known for time series models with relatively short runs of observations. There are theoretical reasons as well as econometric ones, however, for preferring the first differenced form of the regression equations. When one develops an index of some independent variables--e.g., Ermisch's indexes of men and women's real wages--and then uses the natural logarithm of this index as a variable in the regression equation, the size of the estimated regression coefficient is very sensitive to the size of the base arbitrarily assigned to the index. In a forthcoming note in the American Economic Review, Krämer and Neusser show that the estimates of Butz and Ward (1979) are subject to precisely this kind of difficulty.

While Ermisch avoids this particular difficulty by using first differences of the natural logarithms, he thereby encounters a problem which was avoided in the Butz and Ward formulation. This is the problem of using two-stage least squares estimation techniques for determining the coefficients of a two equation simultaneous system when the dependent variable in one equation (K or the proportion of married women of

child-bearing age in the labor force) enters the other equation as an independent variable only in combination with other independent variables (either $K \cdot d\ln Y_m$ or $K \cdot d\ln W_f$). Ermisch's solution, and the one adopted here, is to develop an instrumental variable for K and to use the values of this estimated K in place of observed values of K in the first equation.

Using the Farrar-Glauber technique of examining the potential for multi-collinearity among a set of explanatory variables, I found serious problems in each of my duplicating equations. The Farrar-Glauber technique proceeds in three steps: 1) a Chi square test on the determinant of the matrix of correlation coefficients of the independent variables in order to determine whether overall departures from orthogonality are significant; 2) an F-test on the diagonal elements of the inverse correlation matrix to determine which independent variables have most serious problems of multicollinearity; and 3) t-statistics on the off-diagonal elements of the inverse correlation matrix to see which of the collinear variables are best eliminated. (Farrar and Glauber, p. 104). Table 6, Sections A1 and A2, shows the results of the three-step procedure for the Becker thesis equations estimated by Ermisch and Wander. In each case, the Chi-square statistic indicates a serious overall problem of multicollinearity. It is 103.7 (3 degrees of freedom) for Equation A2 and 330.72 (6 degrees of freedom) for Equation A1. Examining the F-statistics indicates that all the variables have a high degree of interrelatedness with the others, but the problems are much less severe with the Ermisch version. Within Ermisch's version, the first differences of men's real wages and the same first differences multiplied by the proportion of women in the labor force are clearly the worst offenders.

Table 6. Farrar-Glauber tests for Multi-Collinearity in Equations A1 and A2.

A1: Over-All: (Chi-Square, 6 D.F.) 330.72

Tests on Individual Variables (F(23,3) D.F.)

Status Am	MO, HH Y	WO, HH Y	MW, HH Y
411.448	570,893	9450.765	11925.389

Partial Correlations on Lower Diagonal--T Statistics on Upper Diagonal

	Status Am	MO, HH Y	WO, HH Y	MW, HH Y
Status Am	1.000	4.616	1.279	-0.949
MO, HH Y	.693	1.000	-4.752	4.870
WO, HH Y	.258	-.704	1.000	38.972
MW, HH Y	-.194	.713	.993	1.000

A2: Over-All: (Chi-Square, 3 D.F.) 103.70

Tests on Individual Variables (F(22,2) D.F.)

K*DLnWRW	DLn MRW	K*DLnMRW
39.019	252.666	314.096

Partial Correlations on Lower Diagonal--T Statistics on Upper Diagonal

	K*DLnWRW	DLn MRW	K*DLnMRW
K*DLnWRW	1.000	-.541	2.342
DLn MRW	-.115	1.000	11.086
K*DLnMRW	.447	.921	1.000

The effects of altering the structure of both Becker models to allow for the substitution of any one of the independent variables for linear combinations of the other independent variables are explored in Table 7. I include as well equations where the change in the percentage of the German labor force that was foreign is one of the independent variables. The purpose of this is to make explicit the effects upon the estimated coefficients in regression equations of the multicollinearity discovered and displayed in Table 6 and to contrast the superior results obtained when superior information is used--in this case, the effects of changes in the proportion of foreigners in the labor force. To limit our demands upon the patience of the reader, only the results for Ermisch's version of the Becker thesis and his preferred "mixed" model are displayed. The latter model allows an explicit test between the Becker and Easterlin theses in a single estimating equation.

Table 7 about here

The results of Table 7 are very instructive. The coefficients of the most collinear pair of variables, men's real wages (X_2) and men's real wages times the participation rate of women in the labor force (X_3), are quite stable as long as both are included in a regression. When one or the other is omitted, however, the estimated coefficients vary widely on the other. The coefficient variable specific to the Becker model--on the women's real wage multiplied by the participation rate of women in the labor force (X_4)--varies considerably but never seems to be quite significant, sometimes showing the predicted negative sign but often appearing with a positive sign. The coefficient on the variable

Table 7. Regression Results with an Open Economic-Demographic Model.

Eqn. No.	Period	X_2	X_3	X_4	X_5	X_6	Constant	R^2 adj.	D-W
1a	1957-77	6.55	-16.86	2.87	--	--	-0.047	.479	1.8
		(4.07)	(-4.32)	(1.69)			(-2.12)		
1b		7.15	-17.43	0.56	--	--	--	.379	1.9
		(4.12)	(-4.09)	(0.396)					
2a	1954-77	6.71	-17.50	2.91	--	--	-0.040	.511	1.9
		(4.88)	(-5.06)	(1.88)			(-2.14)		
2b		6.74	-16.86	0.86	--	--	--	.429	1.9
		(4.53)	(-4.53)	(0.66)					
3a		6.38	-15.59	2.38	--	-0.02	-0.045	.57	2.1
		(4.92)	(-4.63)	(1.62)		(-1.99)	(-2.51)		
3b		6.46	-15.18	0.22	--	-0.02	--	.46	1.9
		(4.43)	(-4.01)	(0.16)		(-1.51)			
4a		--	-0.526	2.07	--	-0.02	-0.05	.08	0.9
			(-0.25)	(0.96)		(-1.80)	(-1.78)		
4b		--	0.086	-0.19	--	-0.02	--	-.016	0.8
			(0.04)	(-0.10)		(-1.52)			
5a		6.29	-13.39	--	--	-0.02	-0.03	.54	1.9
		(4.67)	(-4.18)			(-2.24)	(-1.85)		
5b		6.43	-14.89	--	--	-0.16	--	.49	1.9
		(4.53)	(-4.55)			(-1.69)			
6a		0.92	--	-0.36	--	-0.03	-0.04	.139	0.9
		(1.20)		(-0.19)		(-2.43)	(-1.61)		
6b		1.12	--	-2.26	--	-0.03	--	.074	0.9
		(1.43)		(-1.45)		(-2.15)			
7a	1959-77	6.99	-17.42	2.46	0.66	--	-0.08	.407	1.8
		(1.99)	(-2.30)	(1.12)	(0.48)		(-1.00)		
7b		9.34	-22.67	2.24	-0.64	--	--	.407	1.8
		(3.58)	(-4.15)	(1.03)	(-1.47)				
8a		--	--	2.57	2.59	-0.028	-0.22	.389	1.9
				(2.20)	(2.48)	(-2.15)	(-3.74)		
8b		--	--	1.52	-0.90	-0.02	--	-.107	0.9
				(0.99)	(-1.43)	(-1.35)			
9a		0.66	--	--	2.68	-0.02	-0.19	.317	1.3
		(1.47)			(2.43)	(-1.77)	(-3.15)		
9b		0.45	--	--	-0.60	-0.02	--	-0.06	0.7
10a		12.73	-25.95	-0.71	-0.63	-0.036	0.0011	.674	2.6
		(4.14)	(-4.24)	(-0.38)	(-0.58)	(-3.53)	(0.018)		
10b		12.69	-25.87	-0.70	-0.61	-0.036	--	.697	2.6
		(6.19)	(-6.49)	(-0.41)	(-1.96)	(-3.92)			

(Table 5 Notes)

(X_1 is the dependent variable in each equation)

X_1 = first differences of natural logarithms of total fertility rate

X_2 = first differences of natural logarithms of index of men's real wages

X_3 = estimated participation rate of women in labor force x X_2

X_4 = estimated participation rate of women in labor force x first differences of natural logarithms of index of women's real wages

X_5 = first differences of natural logarithms of "desired standard of living"

X_6 = first differences of percentage of labor force that is foreign.

specific to the Easterlin model--the ratio of the desired standard of living (taken from household real income ten years previously) to current men's real wages (X_5)--also varies considerably and typically takes on the expected negative sign only when the constant term in the regression is suppressed.

By contrast to these disconcerting results, the estimated coefficient on the open demographic model variable--the change in the percentage of the labor force that is foreign (X_6)--remains remarkably constant regardless of which other variables are included and regardless of whether the constant term is suppressed or not. Further, it always has the expected sign (negative) and is nearly always significantly different from zero at the 5% level. Most interesting is the performance of Ermisch's mixed model when it is expanded to include the effects of immigration upon the labor force (Eqns. 10a-b). The R^2 leaps up by nearly 20 percentage points over the next best performing specification; the constant term becomes insignificantly different from zero with little effect upon the remaining coefficients when it is suppressed; and all the variables included have the expected signs. When the constant term is suppressed, all coefficients are significantly different from zero at the 5% level with the exception of the women's real wage variable. The Durbin-Watson statistic (2.66) confirms the absence of positive serial correlation in the residuals, but lies between the upper and lower bounds of the figure needed to reject or confirm the presence of negative serial correlation.

Overall, the results of Table 7 demonstrate clearly the importance of the open demographic-economic model for the behavior of German postwar fertility. It indicates a marginal superiority of the Easterlin

variable over the Becker variable in such an open system, although both appear to be needed for a full explanation of the variations in German fertility.

SECTION III. Conclusion.

In addition to the bivariate problems of multi-collinearity analyzed in the previous section, we may well suspect the existence of multivariate problems, where a particular independent variable is not closely correlated with any one other independent variable but is closely correlated with a linear combination of two or more of the other independent variables. Obvious candidates for such dependency are the women participation rate in the labor force, women's real wages, and, indeed, the share of foreigners in the labor force. These various possibilities are explored in Table 8.

Table 8 about here

As expected, there is a very strong correlation between the changes in men's real wages and women's real wages, so strong that it swamps the effect of any of the other independent variables. It is interesting to note the positive association of changes in the percentage of labor force that is foreign with changes in both men's and women's real wages (Eqns. 9-11), but the main direction of causality is likely from the real wages in Germany to the proportion of foreigners in the labor force (Eqns. 1-3). It is more interesting to note the negative and usually significant effects of immigration on women's participation rates (Equations 4-7), as well as negative effects of women's participation rates on changes in the importance of foreigners in the German labor

Table 8. Interdependence of the Independent Variables in the Open Economic-Demographic Model (1952-77).

Eqn. No.	Dependent Variable	Independent Variables X_1	X_2	X_3	X_4	X_5	X_6	Constant	R^2	D-W
1	X^6	18.95 (1.22)	-4.218 (-0.23)	--	0.34 (0.03)	-0.28 (-1.58)	--	-0.38 (-0.94)	.198	1.14
2	X_6	15.56 (2.62)	—	--	-1.08 (-0.14)	-0.28 (-1.60)	--	-0.42 (-1.25)	.234	1.13
3	X_6	—	15.75 (2.24)	--	-6.23 (-0.72)	-0.27 (-1.47)	--	-0.46 (-1.16)	.179	1.02
4	X_4	-0.86 (-3.17)	1.35 (4.61)	-0.23 (-2.92)	--	--	-0.009 (-1.90)	-0.02 (-2.08)	.466	1.80
5	X_4	0.18 (0.876)	--	-0.122 (-1.17)	--	--	-0.008 (-1.19)	0.006 (-.57)	-.048	2.39
6	X_4	--	0.57 (2.97)	-0.22 (-2.35)	--	--	-0.013 (-2.41)	-0.016 (-1.49)	.235	2.645
7	X_4	-0.86 (-3.12)	1.39 (4.31)	-0.25 (-2.34)	--	-0.002 (-0.33)	-0.010 (-1.62)	-0.021 (-1.86)	.441	1.847
8	X_2	0.81 (9.24)	--	--	0.366 (3.30)	-0.001 (-0.50)	-0.0007 (-0.24)	0.01 (2.42)	.83	0.569
9	X_2	--	--	--	0.381 (1.67)	0.001 (0.28)	0.012 (2.24)	0.045 (7.92)	.166	1.267
10	X_1	--	.996 (9.24)	--	-0.324 (-2.7)	0.002 (0.69)	0.004 (1.22)	-0.003 (-0.51)	.829	0.85
11	X_1	--	--	--	0.056 (0.22)	0.003 (0.56)	0.016 (2.62)	0.042 (6.68)	.14	1.549

X_1 = first difference natural logarithm, men's real wages

X_2 = first difference natural logarithm, women's real wages

X_3 = first difference natural logarithm, total fertility rate

X_4 = first difference natural logarithm, women's participation rate in labor force

X_5 = first difference, unemployment rate in percentage

X_6 = first difference, percentage of labor force that is foreign.

(t-statistics are in parentheses under the estimated coefficients)

force (Equations 1-3). This negative association, combined with the negative effect of women's participation rates in the labor force on the fertility rate, would imply a positive effect of immigration on fertility. (A rise in immigration implies a fall in women's participation rates, which implies a rise in fertility rates.) However, our results in the previous section were robust in assigning a negative effect to immigration for fertility.

These regression results confirm our impressions formed in Section I above that the large influx of foreign immigrants into West Germany affected the ongoing fertility decline in two distinct ways. First, by moderating the relative rise in wages for young male entrants to the German labor force in the 1960s it discouraged family formation. Second, by moderating the relative rise in wages for young female entrants, it discouraged as well entry of younger women into the labor force. What happened to young German women who were neither getting married nor entering the labor force? It is perhaps not entirely coincidental that the 1960s witnessed a sharp rise in the number of German institutions of higher learning and advanced training with an even sharper rise in the proportion of women continuing their formal education beyond the late teens. While the increased supply of opportunities for advanced education for German women may be seen as wholly exogenous to the economic and demographic movements discussed so far, the possibility remains that some of the demand-side response to these opportunities may have been endogenous to our model. If so, then the influx of foreign workers in the 1960s may have contributed not only to a short

run reduction in fertility rates but also to a longer term fall by encouraging a rise in the education levels of German women.

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